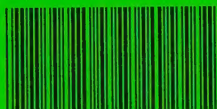


SCALAR DETECTORS

6230 SERIES



MP MASTER



MA31168

Instruction Manual

SCALAR DETECTORS 6230 SERIES

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PREFACE

WARNINGS, CAUTIONS and NOTES

The following terms have specific meanings in this manual:

WARNINGS contain information to prevent personal injury.

CAUTIONS contain information to prevent damage to the equipment.

Notes contain important general information.

HAZARD SYMBOLS

The meaning of the hazard symbol appearing on the equipment is as follows:-

Symbol	Nature of hazard	Reference in manual
	Precision connector	Page iv

CONVENTIONS

The following conventions apply throughout this manual:

(1) Sequence of steps in a procedure.

[CAPS] Capitals in square brackets indicate hard key titles.

[*Italics*] Italics in square brackets indicate soft key titles.

MANUAL AMENDMENT STATUS

Each page bears the date of the original issue or the date of the latest amendment. Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

OPERATING PRECAUTIONS

This accessory, when used with 6200 Series Microwave Test Set, is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition.

WARNING - TOXIC HAZARD

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

CAUTION - PRECISION CONNECTOR

The precision microwave connectors fitted to the detectors may be damaged by mating with a non-precision type. Damage to the connectors may also occur if the connector interface parameters are not within specification. This should be checked with the appropriate gauging tool (see Chapter 3).

CAUTION - MEASUREMENT ERRORS

To guarantee performance of the detector and to ensure repeatability of results, the precision sensor connectors and their mating connectors should be cleaned and gauged before use. (These are covered in Chapters 5 and 3 respectively.)

CAUTION - EXCESSIVE INPUT POWER

The 6230 Series scalar detectors utilise zero biased Schottky diodes. These are of a physically small geometry and consequently can be damaged under high power conditions. **It is strongly recommended that care is taken to avoid exceeding an input power of +20 dBm during normal operation.**

Chapter 1

GENERAL INFORMATION

FEATURES

The 6230 Series Scalar Detectors are used in conjunction with the 6200 Series Microwave Test Set (MTS) for detecting microwave power over a wide dynamic range.

The detected signal is processed by the MTS to produce a power reading which can be displayed as absolute power, insertion loss/gain, return loss or VSWR.

The MTS applies linearity correction for power levels outside the square law response region of the detector diode, i.e. that region of the diode's response where the DC output voltage is no longer proportional to the input microwave power. This improves accuracy at power levels above -30 dBm. The MTS can also compensate for variations in ambient temperature which would otherwise affect the accuracy of the power measurement. Since the MTS can identify the type of detector connected to any of its inputs it can automatically apply the correction appropriate to the detector being used.

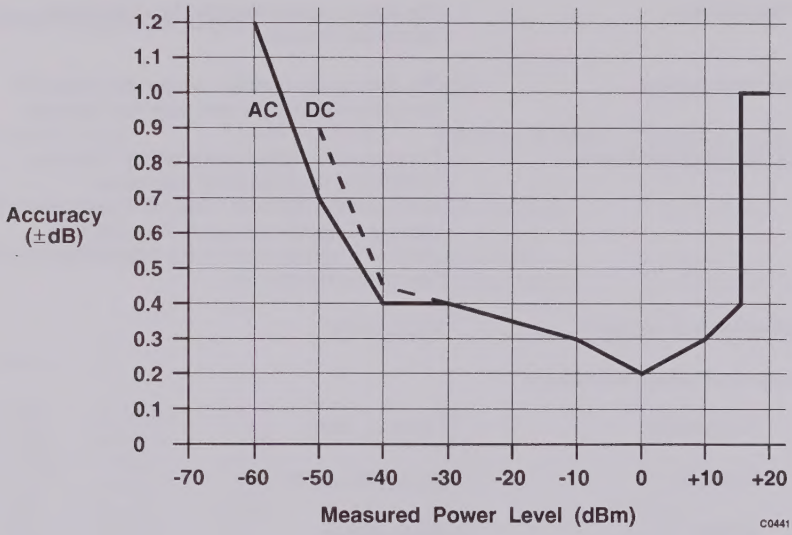
PERFORMANCE DATA

	6230	6233	6234
Frequency range:	10 MHz to 20 GHz	10 MHz to 26.5 GHz	10 MHz to 40 GHz useable to 46 GHz
Dynamic range:	-70 to +20 dBm	-70 to +20 dBm	-70 to +20 dBm
Maximum RF Input:	+26 dBm CW +30 dBm peak for 2 μ s	+26 dBm CW +30 dBm peak for 2 μ s	+26 dBm CW +30 dBm peak for 2 μ s
VSWR:			
10 MHz - 40 MHz	1.4:1	1.4:1	1.58:1
40 MHz - 100 MHz	1.15:1	1.15:1	1.15:1
100 MHz - 2 GHz	1.12:1	1.12:1	1.12:1
2 GHz - 5 GHz	1.17:1	1.17:1	1.33:1
5 GHz - 18 GHz	1.29:1	1.29:1	1.33:1
18 GHz - 20 GHz	1.5:1	1.5:1	1.5:1
20 GHz - 26.5 GHz	-	1.5:1	1.5:1
26.5 GHz - 33 GHz	-	-	1.5:1
33 GHz - 40 GHz	-	-	1.95:1
Frequency response:			
10 MHz - 50 MHz	± 0.5 dB	± 0.5 dB	± 0.5 dB
50 MHz - 8 GHz	± 0.5 dB	± 0.5 dB	± 1.0 dB
8 GHz - 18 GHz	± 0.65 dB	± 0.65 dB	± 1.0 dB
18 GHz - 20 GHz	± 1.25 dB	± 1.25 dB	± 1.5 dB
20 GHz - 26.5 GHz	-	± 1.25 dB	± 1.5 dB
26.5 GHz - 40 GHz	-	-	± 2.0 dB at -7 dBm input power
RF connector	Precision Type N, male	Precision MPC 3.5 mm, male	2.92 mm, male
Dimensions and weight			
Length	90 mm	79 mm	84.1 mm
Diameter	27 mm	27 mm	27 mm
Weight	260 g	250 g	250 g

Self identification	The detector can be identified by a 6200 Series Microwave Test Set.
Temperature sensor	The detector incorporates a temperature sensor for use by the 6200 temperature correction functions.
Radio frequency interference	Conforms to the requirements of EEC Directive 76/889 as to the limits of r.f. interference. Complies with VDE 0871 June 1978 (limit value class B) as specified in licence Vfg 1046/1984 when used in conjunction with a 6200 Series Microwave Test Set.
Limiting range of operation	0°C to +55°C
Conditions of storage and transport	
Temperature	-40°C to +70°C
Humidity	Up to 95% at 35°C
Altitude	Up to 2500 m.

Power accuracy:	Measured Power Level (dBm)	AC Detection (dB)	DC Detection (dB)
	-60	±1.2	-
	-50	±0.7	±0.9
	-40	±0.4	±0.45
	-30	±0.4	±0.4
	-20	±0.35	±0.35
	-10	±0.3	±0.3
	0	±0.2	±0.2
	+10	±0.3	±0.3
	+13	±0.35	±0.35
	+16	±0.4	±0.4
	+16 to +20	±1	±1

A graphical representation of power accuracy is shown on the following page.



Notes...

- (i) Specification applies at 50 MHz for 23°C ±5°C and ignores errors due to mismatch and harmonics.
- (ii) Performance between +16 dBm and +20 dBm is typical non-warranted.
- (iii) Different specifications are given for the detectors when using AC or DC detection.

Chapter 2

INSTALLATION

UNPACKING AND REPACKING

Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the detector.

If the detector is to be returned for servicing attach a label indicating the service required, type number, serial number and your return address.

If the original container or materials are not available use a strong double-wall carton packed with shock absorbing material around all sides of the detector to hold it firmly.

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Chapter 3

OPERATION

PRECAUTIONS

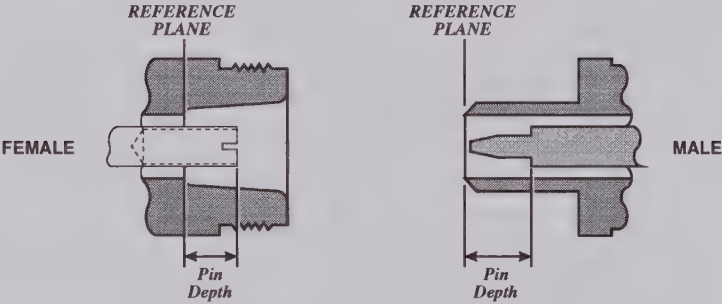
The 6230 Series Scalar Detectors are high-quality, precision detectors and should receive the same care and respect afforded other such devices. Complying with the following precautionary notes will guarantee longer component life and less equipment downtime due to connector or component failure. Also, such compliance will ensure that failures on this component are not due to misuse or abuse, two failure causes not covered under warranty.

- (a) Beware of Destructive Pin depths on Mating Connectors.* Measure the pin depth (Fig. 3-1) of the test device connector before mating it with the detector connector. If the detector is mated with a connector having a destructive pin depth, its connector will probably be damaged.
(A destructive pin depth has a centre pin that is too long with respect to the connector's reference plane.)

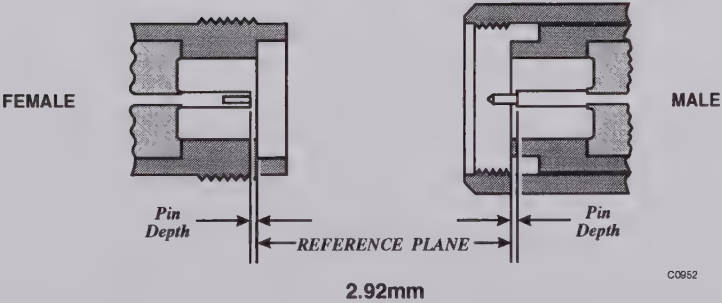
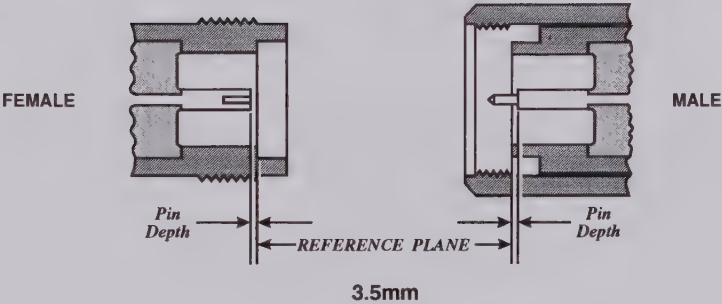
The centre pin of the connector on the 6230 Series detector has a precision tolerance. Connectors on test devices that mate with the detector, however, may not have the proper pin depth. These connectors must be measured before mating to ensure suitability.

When gauging pin depth, if the test device connector measures out of tolerance (Table 3-1) indicating that the centre pin is too long, mating under this condition will probably damage the detector's connector. On the other hand, if the test device connector measures out of tolerance in the opposite direction, indicating that the centre pin is too short, then a mating, while not causing any damage, will result in a poor connection and will degrade the quality of the measurement.

*The term "pin" is used in a generic sense. It refers to both the centre conductor pins on male connectors and the centre conductor sleeves on female connectors.



TYPE N



C0952

Fig. 3-1 Connector Pin Depth

TABLE 3-1 PIN DEPTH TOLERANCES FOR 6230 SERIES DETECTORS

Connector type	Pin depth (inches)	Pin depth (mm)
Type N (male)	0.208 + 0.003 0.208 – 0.000	5.28 + 0.076 5.28 – 0.000
Type N (female)	0.207 + 0.000 0.207 – 0.003	5.26 + 0.000 5.26 – 0.076
3.5 mm (male)	+0.003 –0.000	+0.076 –0.000
3.5 mm (female)	+0.003 –0.000	+0.076 –0.000
2.92 mm (male)	+0.003 –0.000	+0.076 –0.000
2.92 mm (female)	+0.005 –0.000	+0.127 –0.000

- (b) **Avoid Over-Torquing Connectors.** Applying too much torque to the connectors that mate with the detectors is destructive, because it may damage the connector centre pin or may cause the connector body to turn in its housing. Finger-tight is usually sufficient, especially on type N connectors. Should it be necessary to use a torque wrench to tighten 3.5 mm connectors, use a torque wrench that breaks at 8 lb in (1 Nm). **NEVER USE PLIERS TO TIGHTEN CONNECTORS.**
- (c) **Avoid Applying Excessive Power.** Applying power levels beyond the maximum rated values, of even short durations, can seriously damage the detector's internal components.
- (d) **Avoid Mechanical Shock.** The detectors are designed to withstand years of normal bench handling. Do not drop or otherwise roughly handle them, however. They are shipped from the factory in sturdy, foam-rubber padded boxes which should be used for storage when the detectors are not in use.
- (e) **Keep Component Connectors Clean.** The precise geometry that makes possible the detector's high performance can be easily disturbed by dirt and other contamination adhering to connector interfaces. When not in use, keep the component connectors covered. Refer to page 5-1 for cleaning instructions.

OPERATING PROCEDURE

The 6230 Series Scalar Detectors may be connected to any of the four inputs (A, B, C or D) of the MTS. The MTS automatically determines the type of detector connected to a given input provided 'Correction Auto Sense' has been selected (which is the default situation after pressing [PRESET]) and applies the appropriate detector correction accordingly. If however 'Correction User Set' has been selected the appropriate detector correction must be selected manually by pressing [MEASURE] [General Set-up] [Detector Correction] [Input A(B, C or D)]. *Refer to the [MEASURE] key section in Chapter 3 of the MTS Operating Manual for further information.*

When making low level measurements (< -40 dBm) it is important to remove the effects of zero drift by zeroing the detectors. At power on, or after pressing the [PRESET] key, the MTS will perform a detector zero on any detectors connected to the inputs of the MTS. If detectors are connected after power on or after a preset operation, a manual detector zero must be performed. This is achieved by selecting [CAL] [Det/Sensor Zero][Zero Detectors]. If 'detector autozeroing' is enabled, the MTS will periodically perform a zero on each of the detectors connected to the inputs of the MTS. *Refer to the [CAL] key section in Chapter 3 of the MTS Operating Manual for further information.*

Chapter 4

TECHNICAL DESCRIPTION

The 6230 Series Scalar Detectors utilise zero biased Schottky diodes to produce a DC voltage proportional to the applied RF power.

Fig. 4-1 shows the circuit diagram for the 6230/6233 detectors. All detectors include a DC blocking capacitor C1 which guarantees all measurements are insensitive to DC bias produced by the DUT. Resistor R4 provides the RF matching for detector diode D1, and capacitors C2, C3 provide an RF bypass to ground which removes any stray RF signal on the DC output. Static protection is provided on the matching substrate by Zener diode D2.

Resistors R1 and R2 are used to normalize the sensitivity of the detector diode and are set up as described in Chapter 5.

All detectors incorporate a temperature sensing transistor TR1, which allows temperature correction to be applied when used with the MTS. Resistors R5 and R6 are used to normalize the temperature sensing transistor as described in Chapter 5.

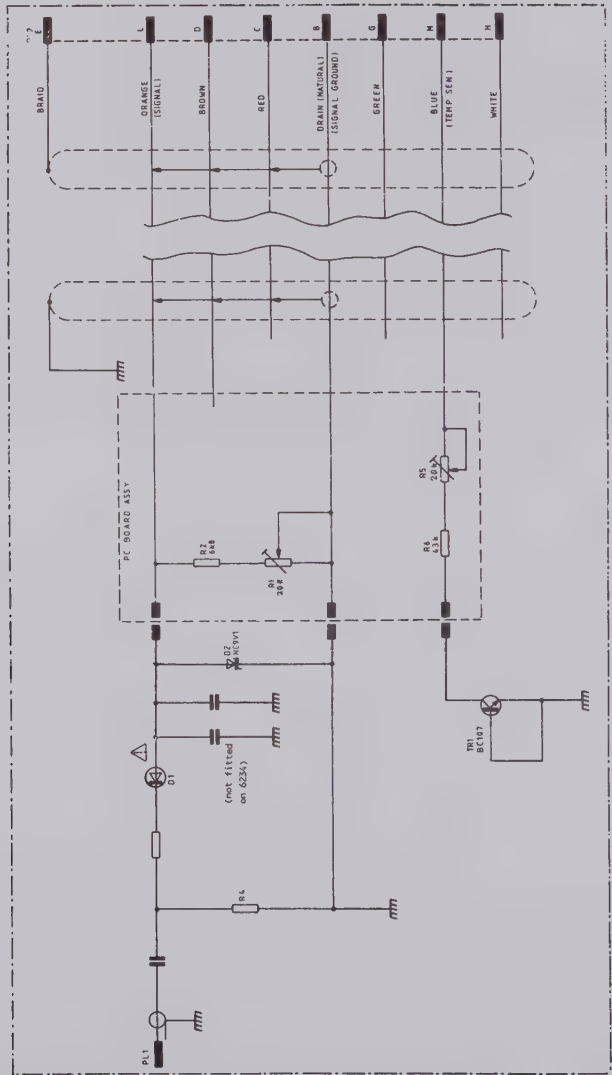


Fig. 4-1 Circuit Diagram of the 6230 Series Detector

Chapter 5

MAINTENANCE

The 6230 Series Detectors contain no user-serviceable parts. Detectors requiring repair must be returned to Marconi Instruments Service Unit (UK), or an authorised service agent.

This chapter describes the procedures which should be performed periodically to maintain the detector in peak operating condition, and to determine if the detector is performing within specification.

CONNECTOR CLEANING

Connector interfaces, especially the outer conductor mating interface, should be kept clean and free from dirt and other contamination. The recommended cleaning agent is isopropyl alcohol (IPA), which should be applied with a clean lint-free cloth or swab.

PERFORMANCE TESTING

POWER ACCURACY

SPECIFICATION

Power accuracy
at 50 MHz
(DC Detection mode) -
At 23°C ±5°C

Power level	Accuracy
-50 dBm:	±0.9 dB
-40 dBm:	±0.45 dB
-30 dBm:	±0.4 dB
-20 dBm:	±0.35 dB
-10 dBm:	±0.3 dB
0 dBm:	±0.2 dB
+10 dBm:	±0.3 dB
+16 dBm:	±0.4 dB*

*Performance above +16 dBm is non-warranted.

TEST EQUIPMENT

Description	Minimum specification	Example
Microwave Test Set (MTS)	6200 Series	MI 6200, 6203, 6204
Medium Range Power Sensor	Freq range to match UUT* Power range -20 to +16 dBm	MI 6910, 6913, 6914
High Sensitivity Power Sensor	Freq range to match UUT* Power range -60 to -20 dBm	MI 6920, 6923, 6924
Signal Generator	Power range -60 to +16 dBm at 50 MHz	MI 2030 option 003

* Unit Under Test

Test Procedure

This test is divided into two parts. First, a signal generator (fitted with high output power option) is calibrated by setting several nominal power levels at 50 MHz and accurately measuring the actual power output using the MTS power meter on input D. Then, using the data acquired from the signal generator calibration, a power accuracy test is performed on the UUT 6230 Series detector.

This test requires that the MTS power meter and sensors have a valid calibration traceable to National Standards.

Signal Generator Calibration

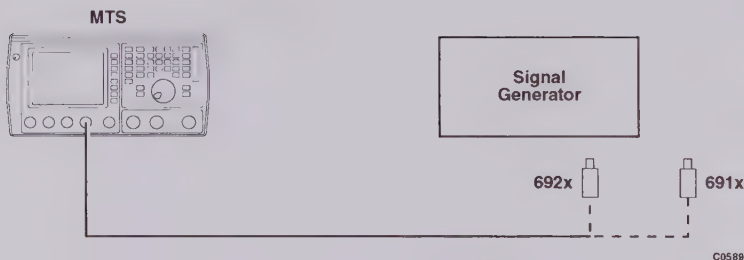


Fig. 5-1 Signal Generator Calibration Set-up

Note...

Avoid unnecessary handling of detectors and sensors, which can cause thermal drift and result in measurement errors, particularly at low power levels.

- (1) Connect the equipment as shown in Fig. 5-1, using the high sensitivity sensor. Connect the sensor to the MTS POWER REF output via the 30 dB pad. Put the MTS into power meter mode as follows:

[PRESET]
[Yes]
[Readout]

- (2) Calibrate the sensor as follows:

[CAL]
[Sensor Cal]

Set the Cal Factor and Linearity Factor to the values given on the sensor's label (use the 50 MHz Cal Factor), then press:

[Continue]

- (3) Now connect the sensor to the signal generator RF OUTPUT. Set the signal generator to output a CW frequency of 50 MHz at a level of -50 dBm. Using Table 5-1, record the power meter reading at this level.

Hint: Select the [MEASURE] menu and use [Restart Averaging] each time the input level is changed. Wait for completion of the averaging cycle, which is indicated by the averaging flag changing from 'a' to 'A'.

- (4) Change to the next level, record the reading, and continue to complete the table up to a level of -30 dBm using the high sensitivity sensor.
- (5) Now connect the medium power sensor and repeat steps (2) to (4), recording power meter readings for levels of -20 to +16 dBm.

Power Accuracy Test

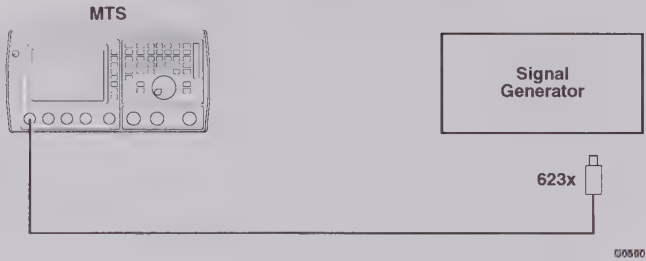


Fig. 5-2 Power Accuracy Test Set-up

- (1) Connect the equipment as shown in Fig. 5-2. Change the MTS to scalar mode and set to accept scalar detectors on all four inputs. With the 6230 Series detector connected to the desired input, e.g. A, define this input as the active measurement:

```
[CHANNEL MODE]
[Scalar]
[MEASURE]
[General Set-up]
[Input Configuration]
[All Inputs are Scalar]
[MEASURE]
[Single Input A, B, C or D]
[A]
[Return to Measure]
[Averaging]
[Averaging] ... (ON)
```

- (2) Before performing any measurements, turn off the autozeroing facility and zero the detector (turn the signal generator RF off if the detector is connected):

```
[CAL]
[Det/Sensor Zero]
[Detector Autozeroing] ... (OFF)
[Zero Detectors]
```

- (3) Set the signal generator output level to -50 dBm (at 50 MHz) and turn on the RF. Note the MTS scalar reading from the Trace Information Area on the display and record under MEAS in Table 5-1.

Hint: Use the [Restart Averaging] feature as before, and note the reading as soon as possible after the averaging cycle is complete.

- (4) Repeat step (3) at the remainder of the recorded power levels.

- (5) Compare the MEAS results recorded in the previous steps with the ACTUAL POWER readings and record the difference under DIFF. The test limits are determined by adding together:
 - (i) the power accuracy specification and
 - (ii) the measurement uncertainty of the Signal Generator Calibration, allowing for mismatch and sensor uncertainty.
- (6) The procedure may be repeated with the 6230 Series detector connected to other inputs if required.

TABLE 5-1 POWER ACCURACY CALIBRATION TABLE

Nominal Power	Actual Power		A	B	C	D
-50 dBm		Meas				
		Diff				
-40 dBm		Meas				
		Diff				
-30 dBm		Meas				
		Diff				
-20 dBm		Meas				
		Diff				
-10 dBm		Meas				
		Diff				
0 dBm		Meas				
		Diff				
+10 dBm		Meas				
		Diff				
+16 dBm		Meas				
		Diff				

FREQUENCY RESPONSE

Frequency Range	SPECIFICATION		
	6230	6233	6234
10 MHz to 50 MHz	±0.5	±0.5	±0.5
50 MHz to 8 GHz	±0.5	±0.5	±1.0
8 GHz to 18 GHz	±0.65	±0.65	±1.0
18 GHz to 20 GHz	±1.25	±1.25	±1.5
20 GHz to 26.5 GHz	---	±1.25	±1.5
26.5 GHz to 40 GHz	---	---	±2.0 (at -7 dBm input power)

TEST EQUIPMENT

Description	Minimum specification	Example
Microwave Test Set	6200 Series	MI 6200, 6203, 6204
Medium Range Power Sensor	Freq range to match UUT*	MI 6910, 6913, 6914
Power Splitter 2-resistor type	Frequency range & connector to match UUT* 20 GHz N-type 26.5 GHz MPC 3.5 mm 40 GHz 2.92 mm	MI 54311-123S MI 54311-124W MI 54311-161T

* Unit Under Test

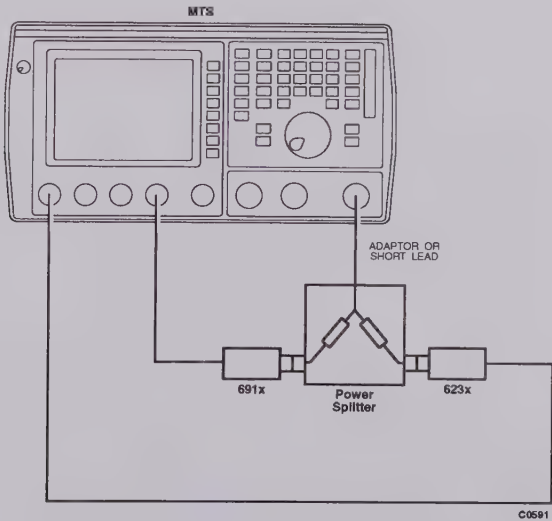


Fig. 5-3 Frequency Response Test Set-up

- (1) Connect the equipment as shown in Fig. 5-3. Before connecting the power sensor to the splitter, preset the MTS and perform a sensor calibration:

```
[PRESET]
[Yes]
[CAL]
[Sensor Cal]
```

Set the Linearity Factor to the value given on the sensor's label, then press:

```
[Continue]
```

When the sensor calibration is complete, connect the sensor to the free output arm of the splitter.

- (2) The MTS source frequency range should be set, if necessary, to match the range of the UUT:

```
[SOURCE]
[Set Stop Frequency...]
[RF] ... (ON)
```

The default source output power setting of 0 dBm is used.

- (3) This test uses a dual channel set-up with the UUT detector supplying a swept channel and a power sensor monitoring spot frequencies in readout mode. This is done as follows:

```
[CHANNEL MODE]
[Dual Channel Display]
```

Channel 1 is a swept channel using a delta marker relative to 50 MHz to show the detector frequency response:

```
[SCALING]
[Autoscale]
[MARKERS]
[Position Active Mkr...]
[5] [0] [M $\mu$ ]
[Delta Mkr]
```

Channel 2 is a readout channel using the dB relative function and links the sensor Cal Factor correction to the source frequency to monitor the true power applied:

[SWITCH CHANNEL]
 [CHANNEL MODE]
[Readout]
 [MEASURE]
[Averaging]
[Input D]
[User Set Averaging]
 [3] [2] [x1]
 [MEASURE]
[General Set-up]
[Sensor Correction]
[Cal Factor Source Freq]
[Select Cal Factor Table...] *
 [MEASURE]
[dB Rel]
[Store Measurement]

* The MTS should have a power sensor calibration data table stored for the sensor in use. If not, the cal factor can be entered manually. Refer to the Sensor Corr Menu in Chapter 3 of the MTS Operating Manual for more details.

(4) Now press:

[SWITCH CHANNEL]
 [MARKERS]

By varying the position of the active marker (using the rotary control or the *[Position Active Mkr]* soft key), the displayed response of the UUT detector on Channel 1 can now be compared against the true power measured by Channel 2. Since the channels are linked, the frequency at which the active marker is positioned will be the frequency at which the power meter measurement on Channel 2 is made.

Examine as many points as necessary to establish that the UUT meets the specified frequency response, paying particular attention to the specification band change points. The test limits are determined by adding together:

- (i) the frequency response specification and
- (ii) the uncertainty of the power meter measurement, allowing for mismatch and sensor uncertainty.

CALIBRATION AND ADJUSTMENT

TEST EQUIPMENT

Description	Minimum specification	Example
Microwave Test Set	POWER REF output calibrated to National Standards	6200, 6203, 6204
Digital thermometer	Accuracy $\pm 0.5^{\circ}\text{C}$	Comark
Adaptor (if required)	N-type to 3.5 mm	

Note...

Ensure that detectors have been left to stabilize at room temperature for at least 2 hours prior to calibration.

Avoid unnecessary handling of detectors, which can result in thermal drift during calibration.

Temperature Calibration

- (1) Connect the detector to be calibrated to Input A on the MTS then select data acquisition diagnostics as follows:

[PRESET]
[Yes]
 [UTILITY]
[Service]
[Diagnostics]
[Data Acq Diagnostics]

- (2) Turn service mode ON as follows:

[Service Mode]
[Set Up Input]
[Select ADC Input]
 [9]

This routes the 6230 Series temperature sensing circuitry directly to the display.

- (3) Check the ambient temperature of the detector with the thermometer probe by placing it as close to the detector's connector as possible, then match the temperature with its corresponding voltage in Table 5-2.

TABLE 5-2 6230 SERIES TEMPERATURE CORRECTION DATA

Temp. (°C)	Voltage (V)	Temp. (°C)	Voltage (V)
17	-1.512	23	-1.498
18	-1.510	24	-1.495
19	-1.507	25	-1.493
20	-1.505	26	-1.490
21	-1.502	27	-1.488
22	-1.500	28	-1.485

- (4) Change the measurement format to volts by pressing:

[FORMAT]
[Volts]

Press the [SCALING] key and enter the voltage taken from Table 5-2 as the REFERENCE LEVEL. Select a SCALE FACTOR of 1 mV/DIV and set the REFERENCE POSITION to centre.

- (5) A trace should now be visible on the display and within ± 1 graticule division of the REFERENCE LEVEL. If necessary, carefully adjust potentiometer R5 (Fig. 5-4) until the trace position matches the REFERENCE LEVEL. This adjustment will now give the correct temperature correction offset, when enabled.

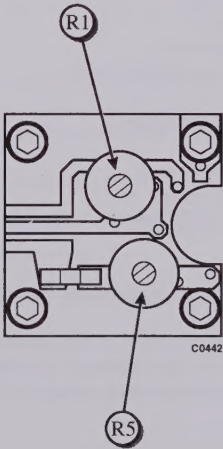


Fig. 5-4 PCB Layout

0 dBm Sensitivity Calibration

- (6) PRESET the MTS, select READOUT mode and select Input A:

[PRESET]

[Yes]

[Readout]

[MEASURE]

[Measurement Functions]

[Single input A,B,C, or D]

[A]

- (7) Turn temperature correction ON:

[MEASURE]

[General Set-up]

[Detector Correction]

[Input A]

[Temperature Correction]

- (8) Connect the detector to the POWER REF output, using the N-type to 3.5 adaptor if necessary. Turn the power reference ON using:

[CAL]

[Power Ref]

- (9) Carefully adjust the detector sensitivity potentiometer R1 (Fig. 5-4) until the readout indicates 0.00 dBm $\pm$ 0.01 dB.

